Street Tree Inventory
and
Management Plan

For the

City of Flint, Michigan

Tree Inventory

and

Management Plan

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August, 2015

Prepared by:

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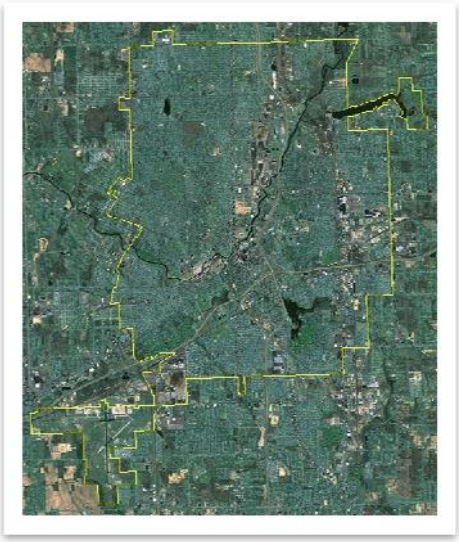
Executive Summary

The City of Flint, Michigan is the largest City and county seat of Genesee County incorporated in 1855. The City's historic neighborhoods, parks, and tree lined streets define this diverse and proud community. The economic health of Flint, as with many communities, is closely related to the ability of the municipal government to supply its citizens with efficient services, safe public spaces, and properly maintained infrastructure. Trees are an integral component of this urban environment. Their shade and beauty contribute to the community's quality of life and soften the hard appearance of concrete structures and streets. They help stabilize the soil by controlling wind and water erosion. Trees also help reduce noise levels, cleanse pollutants from the air, produce oxygen and absorb carbon dioxide, and provide habitat for wildlife.



Trees also provide significant economic benefits, including increased real estate values. Trees provide shade and act as windbreaks, helping to decrease residential energy consumption. Unlike other components of the City's infrastructure, the tree population, with proper care, will actually continue to increase in value with each passing year. When properly maintained, trees return overall benefits and value to the community far in excess of the time and money invested in them for planting, pruning, protection, and removal.

Managing natural resources in urban areas is challenging in the very least. For many communities, finding suitable space for trees among streets, buildings, sewers, and utility lines is difficult. Frequently, a greater concern is providing adequate maintenance within budget constraints. A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations.

The Flint Street Tree Population

In 2013- 2015, Knowles Municipal Forestry, LLC performed an inventory of 31,273 trees, stumps and planting sites in Flint. This street tree data has now been evaluated to provide management strategies for the City. The major findings of the *Tree Inventory and Management Plan for the City of Flint* include the following:

- Knowles Municipal Forestry, LLC inventoried 31,273 total sites. Of these, 29,004 are street trees, 2,173 are planting sites and 96 are stumps along streets.
- 60 genera and 155 species are represented in the inventoried trees.
- *Acer* spp. (maple) comprises 62% of the inventoried tree population, with *Gleditsia spp*. (Honeylocust) 9%, *Tilia spp*. (Linden) 8%, and *Ulmus* spp. (elm) 5%.
- Small trees, which are six inches and less in diameter, represent 7% of the total tree population, 69% of the trees are medium-sized (7 to 24 inches in diameter), and only 24% of the trees are large-sized (25 inches and greater in diameter).

- The majority of street tree conditions were rated fair to good in both structural condition (88%) and functional conditions (60%)
- There are 22,870 trees (74%) recommended for pruning in the total population. Of these, 1,739 (6%) are recommended for Training, 383 (1%) are recommended for Thinning, 7,576 (24%) are recommended for Raising, and 13,172 (42%) are recommended for Cleaning.
- Removal is recommended for 6,134 (20%) of the inventoried trees and sites.
- Pruning and removal maintenances were prioritized as 1,752 (6%) Young, 7,727 (27%) Routine, 14,490 (50%) Immediate, and 5,035 (17%) Critical.
- A total of 96 (.3%) stumps are in need of grinding.
- There are 2,173 planting sites currently inventoried as available for trees.
- Emerald ash borer was recorded on three trees in the inventory and all ash (*Fraxinus*) trees have been recommended for removal.
- The total value of Flint's street tree population is estimated to be **$34,124,559.06**. This number is based on the tree valuation methodology found in the Council of Tree and Landscape Appraisers' publication, *Guide for Plant Appraisal (Ninth Edition).*
- $10,204,050 is required to properly maintain the current street tree population. The annual cost to implement this program into a six year cycle would be $989,528 for pruning and removals, and $711,147 for planting for a total of $1,700,675 a year.
- The annual value of environmental benefits for the current street tree population is $5,792,286.
- For every $1.00 spent on public street trees, the City will receive $3.41 in environmental benefits.
- The City currently has 31.5% urban tree canopy cover.
- The annual value of environmental benefits for the urban forest canopy $18,447,150.52.

Purpose

The Genesee County Conservation District has recognized the need for proactive tree maintenance and commissioned a study of the public street tree population. The intent of this study is to inventory and evaluate the current condition of this valuable asset. In recent years, the City's tree care has declined due to budget restrictions and has focused on reacting only to tree emergencies rather than proactive management. The purpose of this *Tree Inventory Management Plan* is to provide a more balanced plan of action for the inventoried tree and site population of Flint. The inventory draws attention to immediate risk and provides the basis for designing a long-term management plan. The management plan, in turn, provides guidelines for the future, allows for more effective use of tree care funds, and allows for more accurate budget projections.

Methodology

The first phase of what was to be a six year inventory project was completed for the City of Flint in the summer of 2013. This phase identified 3,017 public street trees and 2,178 planting sites in the northwest section of the City. The intent of this project was to identify priority tree maintenance needs and planting sites. These needs would then be addressed as they are discovered on an annual basis.

After completing the first year of the project, the City realized the value of this data and procured funding which allowed for an accelerated timeline. For the next phase of data collection, planting sites and stumps were not collected in order to make the best use of the available budget. Knowles Municipal Forestry was able to inventory the remaining 26,078 trees in the winter of 2014–2015. The results were a total of 31,273 trees sites Citywide. This data is now being used to prioritize tree maintenance activities throughout the City to manage risk. The goal of this program is to establish a routine maintenance cycle to be continued as a proactive tree care program.

Definitions and References

American National Standards Institute (ANSI) – A private organization that oversees the development of voluntary standards for products, services, processes, systems and personnel in the United States.

Council of Tree and Landscape Appraisers (CTLA) – authors of tree appraisal standards (CTLA, 2000. *Guide for Plant Appraisal*, 9th Ed. Savoy, IL: ISA 143pp.)

Diameter at Breast Height (DBH) – The diameter (inches) of a trunk cross-section measured at 4-1/2 feet above the ground.

International Society of Arboriculture (ISA) – A worldwide professional organization dedicated to fostering a greater appreciation for trees and to promoting research, technology, and the professional practice of arboriculture.

i-Tree Streets – a street tree management tool for urban forest managers developed by researchers at the USDA Forest Service. i-Tree Streets is a computer application that uses tree inventory data to quantify the structure, function, value and management needs of any street tree resource.

i-Tree Canopy – a canopy assessment tool for any defined project area developed by researchers at the USDA Forest Service. i-Tree Canopy is a computer application that uses Google Maps data to quantify cover types and tree benefits for the urban forest.

Risk (in trees) – The likelihood of all or part of a tree to fail and the severity of the potential consequences of that failure.

Tree – a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow multi-stemmed forms.

Inventory

An inventory of all of the trees along the public streets of Flint was conducted. Data definitions and methodology are described to give an understanding of the inventory process.

Data Collection

All Flint public street tree sites were individually examined, identified, measured, and recorded. Data were entered on hand-held data collection units and transferred to Tree Tracker inventory software for processing. Data collection protocols were specifically designed to incorporate both ANSI standards for tree maintenance and i-Tree data analysis. Tree and site data were recorded for the following street tree variables, which are described in further detail below:

- Tree Address
- Managed By
- Land Use
- Tree Location
- Tree Species
- Tree Diameter
- Tree Condition
- Tree Maintenance Requirements
- Maintenance Priority
- Failure Size
- Root Space
- Sidewalk Damage
- Wires
- Observations
- Identification Number

Address

Every tree site is identified with information based on its physical location on the street. This location information will ensure all maintenance personnel and contractors will be able to identify the appropriate tree in the field. The first location indicator is the **area** that the site is in. The City of Flint was divided into 6 tree management areas in order to better manage this resource. The **address** is the next identifier. Each address includes a *street name* and *address number*. Addresses are determined from the actual address number posted on buildings. In locations where the address number is either not posted or not available, an '**X**' is entered after the street address to indicate that the address has been assigned. These assigned addresses will be determined by using opposite or parallel addresses that can be found in the field.

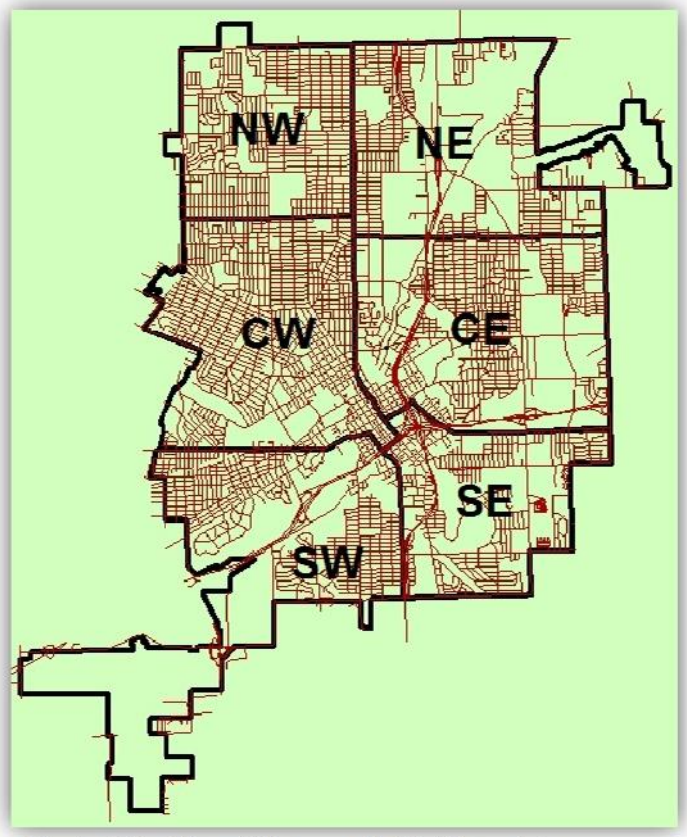
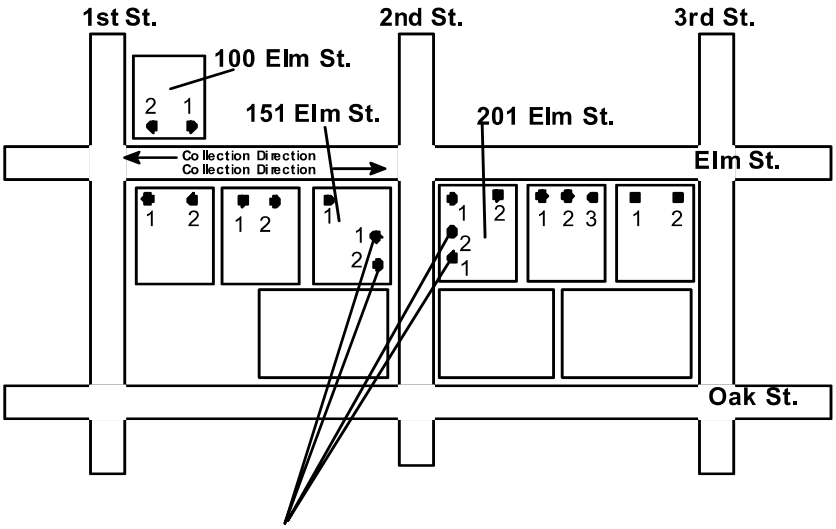


Photo 1 The City of Flint was divided into six tree management areas.

An **on street** will be the actual street the tree site is located on. The *on* street may not be the same as the address street. For example, a corner house may have trees along the side and those trees may actually be on a street that intersects the sites addressed street. Examples of this are shown at 151 Elm St. in the diagram on this page.

Individual tree sites at every address will also be assigned a **site number**. These sites are collected and assigned numbers sequentially in the direction of vehicular traffic flow. In the case of one-way streets, tree sites are collected and assigned site numbers as if they were two-way streets. At each address, a separate number sequence is used for each side (front, side, rear, and median/island). This means that the trees at the front may be numbered 1 through 999 and, if trees are located on the side, rear, or median/island of that same address, each side is also numbered consecutively, again beginning with the number 1 and always in the direction of vehicular traffic flow.

The following diagram gives you a little more detail on how tree site numbering progresses as you move along a street:



These four tree sites are on 2nd St., but have Elm St. addresses.

Managed

This field indicates who is responsible for the maintenance of the tree based on its physical location. The management types include *City, Private, Both, and Unknown*. Because this is an inventory of trees on the public right-of-way, most of the trees will be managed by the City. Only private trees that pose an immediate and obvious risk to the public right-of-way are collected. Special attention should also be paid towards trees with portions of the trunk growing simultaneously on both private and public property, as these trees may legally be the responsibility of both property owners. These trees marked as being managed by *both* may also be known as border trees.

Land Use

Trees may be affected by or conversely have an effect on the area in which they are growing. This is based in part on the type of land use in that area. In order to track these influences, land use is recorded in the general types of *Commercial, Industrial, Open Space, Residential*, *School* and *Shopping/Retail*.

Location

The type of space available for tree growth is noted. The location types include: *Yard*, *Tree Lawn*, *Well/Pit*, *Median/Island*, *Un-maintained,* and *Other*.

Root Space

Root space is the narrowest distance (in feet) that will restrict the natural spread of the root system. In most cases this is the distance between the curb and the sidewalk, or the tree lawn width.

Species

Trees are identified by genus and species using both botanical and common names and by cultivars where appropriate.

Diameter

Diameter is measured to the nearest inch in one-inch size classes at 4-1/2 feet above the ground, or diameter-breast-height (DBH).

Condition

Condition indicates the current state of a tree's health, structural soundness, overall shape, and growth rate. Condition ratings are collected in two separate plant health fields for all trees. The condition of the wood (structural condition) and the condition of the leaves (functional condition) was collected. To some extent, condition class is also a reflection of the life expectancy of the tree. Crown development, trunk condition, major branch structure, twig growth rate, insects/diseases, and root condition, among others, are considered. In general, the condition of each tree's structural health and functional health is recorded as one of the following categories adapted from the rating system established by the Council of Tree and Landscape Appraisers (CTLA) tree appraisal standards (CTLA, 2000. *Guide for Plant Appraisal*, 9th Ed. Savoy, IL: ISA 143pp.):

Structural Condition

Good
The tree has no major structural problems, no visible root damage, no significant damage due to diseases or pests, no significant mechanical damage, and a full balanced crown.

Fair
The tree may exhibit minor structural problems and/or mechanical damage, signs of root stress, or minor structural imbalance.

Poor
The tree appears unhealthy and may have structural defects. Trees in this category may also have severe mechanical damage, decay, or root damage.

Dead
This category refers to dead or dying trees.

Functional Condition

Good
The tree has no major significant damage due to diseases or pests, a full balanced crown, and normal twig condition and vigor for its species.

Fair
The tree may exhibit significant damage from non-fatal or disfiguring diseases minor crown imbalance or thin crown or stunted growth compared to adjacent trees.

Poor
The tree appears unhealthy and severe crown dieback or poor vigor/failure to thrive.

Dead
This category refers to dead or dying trees.

Maintenance

Maintenance recommendation information is collected to provide a basis for determining and prioritizing the primary maintenance needs of the inventoried tree population. This information is useful for preparing accurate budgets and for developing maintenance schedules, whether the work is performed by in-house crews or contracted out to local tree care companies. These maintenance categories have been derived from the ANSI A300 pruning standards.

Train
A pruning recommendation to improve structure, health and vigor of a young tree. This will correct structural flaws and make a tree more aesthetically pleasing.

Thin
A selective removal of live branches to evenly distribute crown weight and to reduce density. The intention of this pruning is to reduce wind resistance, reduce snow and ice loads, and to increase light penetration.

Raise
The removal of lower branches from the crown to eliminate obstructions or clearance issues. The majority of these cuts will be made at the tree trunk.

Clean
A crown cleaning to remove dead, diseased, damaged, poorly attached, or crossing branches to increase longevity and reduce failures.

Remove
The complete removal of a dead or dying tree that has no potential of improving with maintenance.

Maintenance Priority

All of the described maintenances are prioritized as to the severity of the recommendation. The following descriptions were used.

Young
This describes a young or newly planted tree that will probably not need immediate attention to increase longevity.

Routine
This maintenance recommendation should be part of a cyclical pruning program.

Immediate
Recommended maintenance should be conducted as soon as possible to ensure the health of this tree and to reduce risk.

Critical
Maintenance needs to be conducted without delay. This tree is a concern to public safety.

Failure Size

The size of the part most likely to fail was recorded. This will help to prioritize the recommended maintenances. This category my make a large branch removal a greater priority than the removal of an entire tree. This is assuming the branch has a larger diameter than the tree trunk diameter. Diameters of parts will be recorded in 12 inch increments.

Hardscape Damage

Hardscape damage was recorded when the inventoried tree has a root system that is conflicting with public sidewalks, curbs, or other infrastructure.

Wires

Noting the presence of utility lines is necessary when planning pruning activities and can be used to identify which sites are more suitable for small growth habit tree species that will not interfere with utility lines when they mature.

Observations

These are common issues which warrant documentation because managing them is essential to any tree management program:

Remove Hardware
Poor Location
Mulched Improperly
Planted Improperly
Pruned Improperly
Pest Problem
Mechanical Damage
Cavity/Decay
Root Problem
Serious Decline
Memorial Tree

Identification Number

Each site is given a unique number to easily identify it on future listings and reports.

Inventoried Tree Population

Tree Population Characteristics

The characteristics of the urban forest include species, diameter, condition, and other related tree and site factors. By identifying the species, diameter, and condition of trees in the urban forest, one can learn much about the forest's composition, relative age, and health. It is important to know the kinds of trees as well as the number of trees present in the City. Species composition data are essential because tree species vary considerably in life expectancy and maintenance needs. The types of trees present in a community greatly affect tree maintenance activities and budgets. Similarly, tree diameter and size class data help to define the general age and size distribution of the total tree population.

Figure 1. Family Distribution

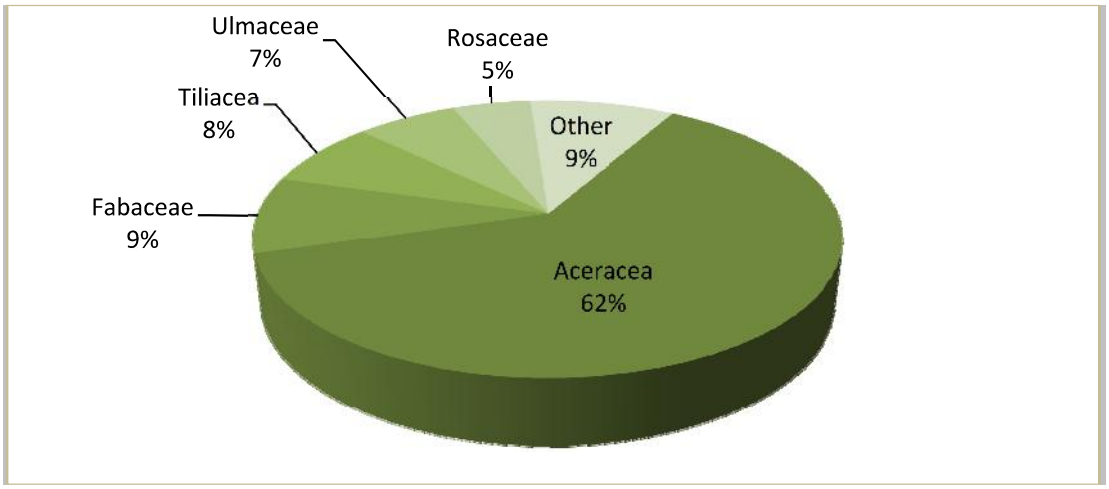


Figure 2. Genus Distribution

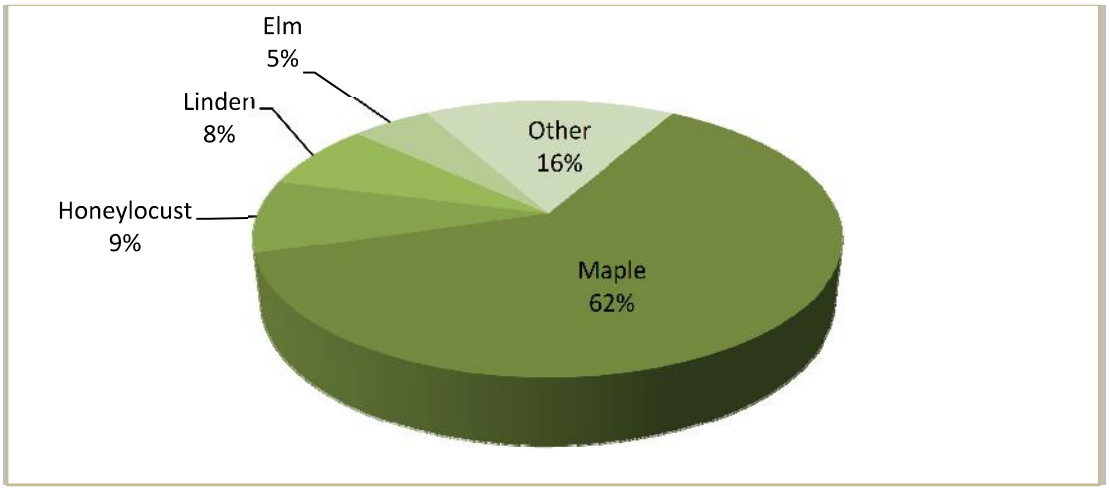


Table 1. Species Distribution

Common Name	Scientific Name	Number of Trees	Percentage
Norway Maple	*Acer platanoides*	11,371	39.2%
Silver Maple	*Acer saccharinum*	3,068	10.6%
Honeylocust	*Gleditsia triacanthos*	2,482	8.6%
Sugar Maple	*Acer saccharum*	2,353	8.1%
Littleleaf Linden	*Tilia cordata*	2,159	7.4%
All Other	*Spp.*	7,571	26.1%
	Total	**29,004**	**100%**

The inventoried street tree population is comprised of over 29,000 trees distributed among 60 genera and 155 species. Table 1 illustrates that five species account for 74% of the street tree population.

Generally, in the field of urban forestry, it is recommended that no single family (a family is a group of closely related genera) should comprise more than 30% of the total population and no one genus (a genus is a group of closely related species) should comprise more than 20% of the total population. Furthermore, no one species should account for 10% of the total population. This is commonly referred to as the 10-20-30 rule. Table 1 shows that the top two inventoried species exceed this recommendation. Furthermore, Figure 1 shows that the genus *Acer* (maple) accounts for 62% of the City's total tree population and also exceeds the recommended percentage of one genus.

The inventory shows that the diversity of Flint's street tree population is not at recommended levels. Planting a large number of trees of the same species (monoculture) can lead to catastrophic results. A good example of this situation was the dominance of American elm (*Ulmus americana*) in American cities in the 20th century. When Dutch elm disease (*Ceratocystis ulmi*) arrived in the United States in the 1930s, the resulting tree losses were devastating. Similar scenarios are now foreseeable for the Asian long-horned beetle (Appendix E) and emerald ash borer (Appendix F).

The City should limit the number of Maple's (*Aceraceae*-family/*Acer*-genus) being planted on public streets. Based on the current tree inventory, even if every tree recommended for removal (6,134 trees) were to be replaced with a non-maple species, there would still be 21% too many maples per the 10-20-30 rule. At a minimum, the City should eliminate Norway maple (*Acer platanoides*) from future plantings until more diversity is obtained.

Table 2. Maple Tree Overpopulation

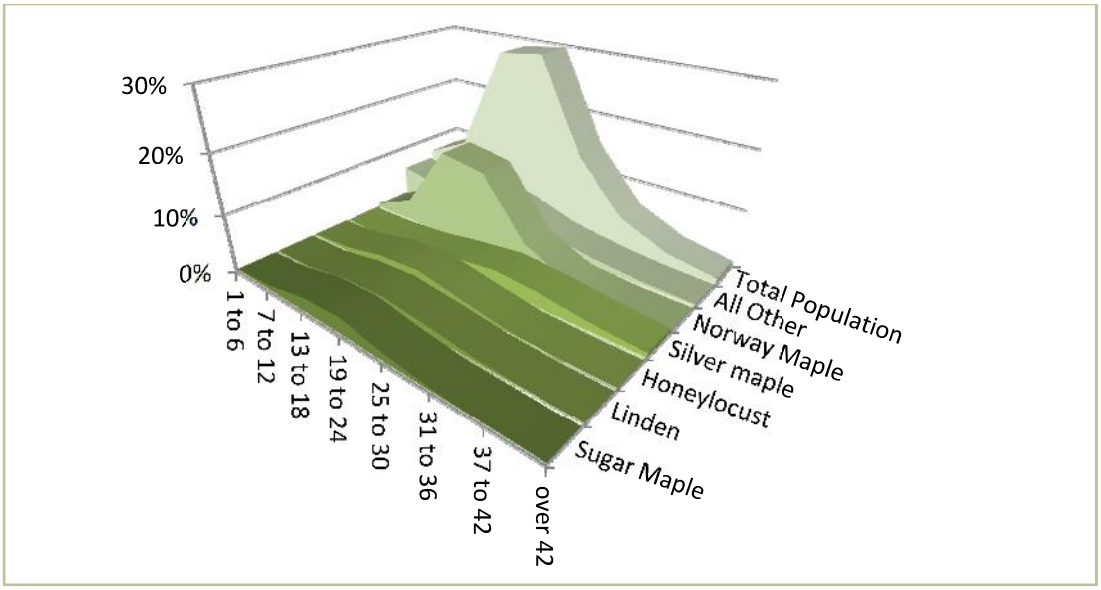
Tree Type	Recommended	Current	Overage
Maple, Family	30 %	62 %	32 %
Maple, Genus	20 %	62 %	42 %
Maple, Norway	10 %	39 %	29 %
Maple, Silver	10 %	11 %	1 %

Percent of the total street tree population

Size Distribution

Species diversity alone is insufficient in maintaining a stable urban forest. Tree species have different life spans and mature at different diameters, heights, and crown spreads. This means that actual tree ages cannot be assumed from the diameters of trees. However, general classifications of size, such as small, medium, and large, can be used to describe the general characteristics of the urban forest. This is not a substitute for age classes, which can give the actual age and maturity of trees, but it can provide a general idea of the variability in the Flint's tree population (Figure 3).

Figure 3. Diameter Class by Species

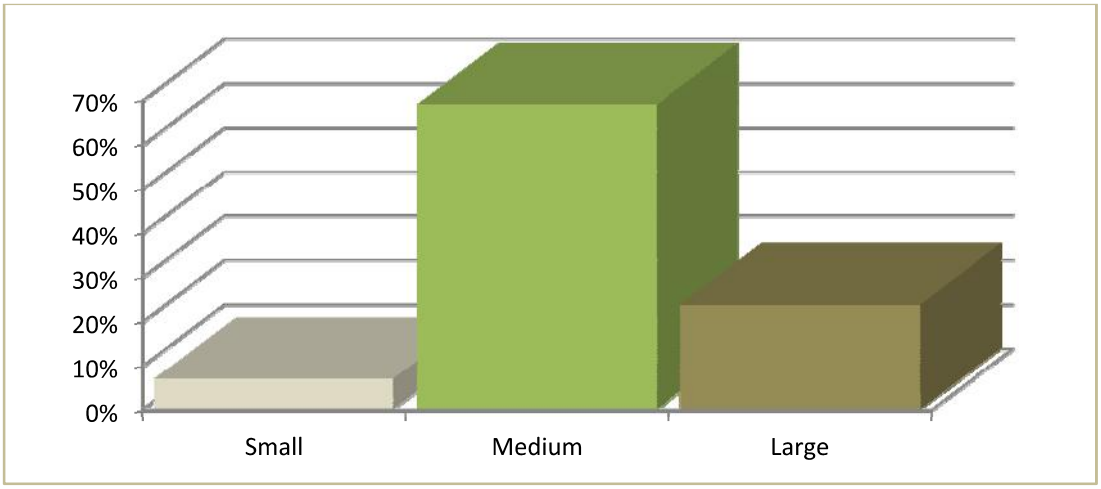


Less than 10% of the total tree population is in the young tree class (1-6 inches). This size class is made up of a diverse population of tree species. These species will eventually grow large enough to provide the type of leaf area and canopy cover that benefits the urban environment the most.

Roughly 70% of the inventoried urban forest falls under the medium-sized classification with a diameter range of 7 to 24 inches. Maple, honeylocust, and linden percentages dominate this size class. These trees are considered mid-aged and have not yet reached their full potential.

Large trees, which are 25 inches and greater in diameter, comprise approximately 24% of the City's inventoried tree population. Norway and Silver maples make up more than half (54%) of this size class. These large canopy but short lived trees are contributing the maximum benefits to Flint's urban tree population both aesthetically and in ecological services (Figure 4).

Figure 4. Diameter Distribution of Entire Population

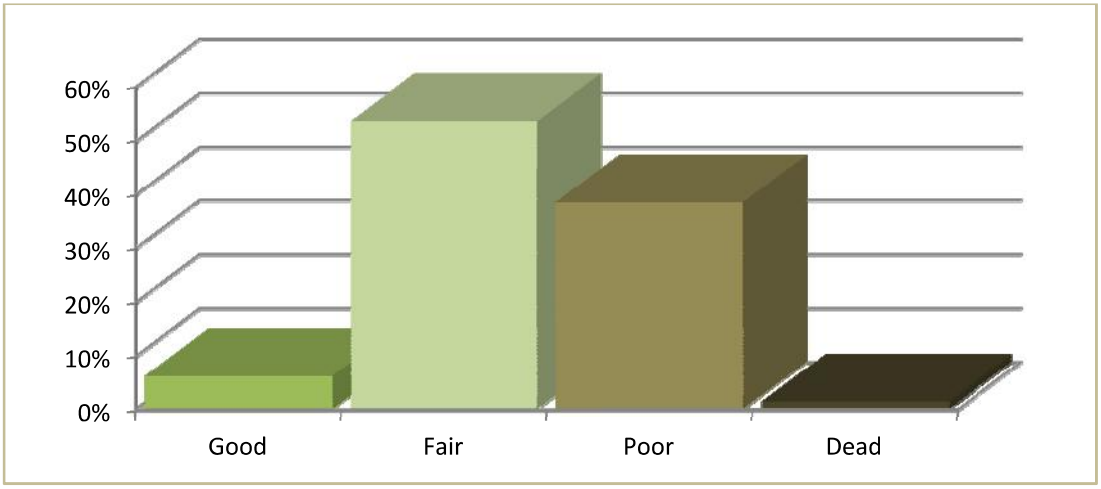


Normal recommendations in urban forestry management call for achieving, over time, an appropriate age mixture by removing and replanting a certain percentage of trees each year. A good ratio for an urban tree population is a 20:60:20 mix of small, medium, and large trees, reflecting the percentage of trees in each size group and representing a uniform spread of tree ages from young to mature to over-mature. By comparison, Flint's current urban forest is a 07:69:24 mix of small, medium, and large trees. This ratio indicates a lack of young, healthy, new tree planting that will eventually lead to a lack of healthy middle aged trees as the urban forest ages. The City of Flint should establish a tree planting program as soon as urban tree risk mitigation has been completed. This planting should focus on both species and age diversity within the urban tree population.

Condition

Condition indicates the current state of a tree's health, structural soundness, overall shape, and growth rate. In order to get a more complete understanding on the health of a tree, condition ratings have been split into two categories. The first is the *structural* health or the condition of the wood and the second is the *functional* health or the leaf condition. The overall health of the tree is a combination of both conditions.

Figure 5. Structural Condition

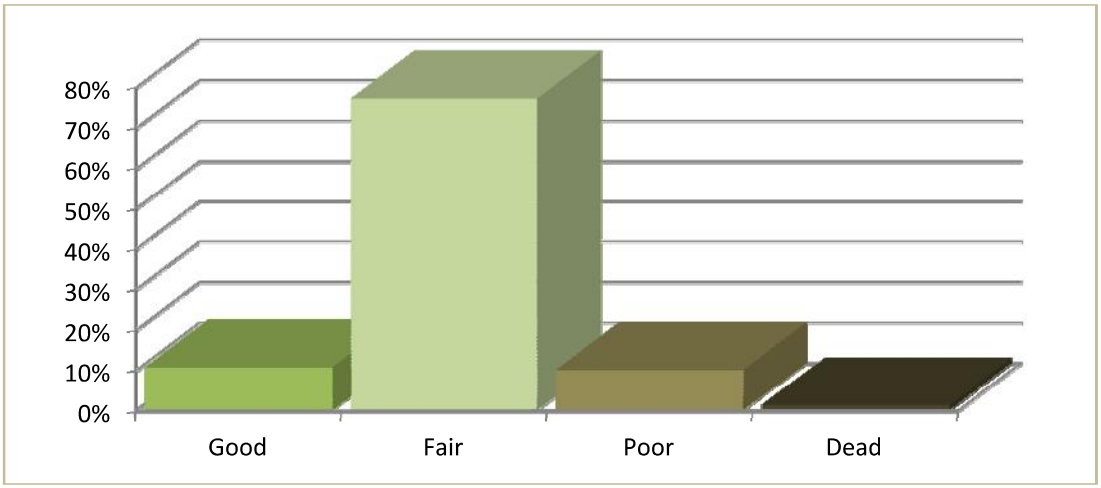


The structural condition of a tree is an evaluation of the trees ability to support its own weight in addition to any loads that it may routinely be subject to. Common loading factors include wind, snow, ice, rain, and even leaf and fruit weight. A tree with good structural health should have no problem supporting these typical stresses.

It is important to understand that a tree that appears healthy, because it is in full leaf or growing rapidly, may still have a poor structural condition. The structural integrity of a tree is determined by many factors. Each tree is evaluated from root to crown for root problems, cavities, decay, pests, cracks, dead wood, and branch structure.

The majority (60%) of Flint's street trees have *fair* to *good* structural condition. This high percentage of structurally sound trees is most likely due to a successful tree maintenance program for the City's street tree population. The majority of the inventoried trees showed signs of routine and appropriate arboricultural practices. It is apparent however, that this type of maintenance has been lacking in recent years. The portion of the population that has *poor* structure (38%) is comprised mostly of over mature and declining trees (Figure 5). *Poor* structural condition also includes trees that are developing poor branch attachments and co-dominate stems. These structural defects will be greatly improved as high risk trees are removed and trees are pruned on a routine cyclical basis.

Figure 6. Functional Condition



To evaluate functional condition, each tree must be inspected for characteristics common for the particular species and cultivar. Tree characteristics may include shoot growth, crown shape, leaf and bud size, shape and color. Irregularities in any of these characteristics or the presence of twig dieback, insect frass, or fungus may decrease this condition rating.

Insects, disease, chemicals, mechanical damge, pollutants, and environmental conditions are all likely factors in a trees functional health. Any one or any combination of these causal agents must be identified and assessed for their impact on the health of each individual species. Some of these problems may be unsightly, but have little impact on the individual tree species. An example of this may be tar spot (*Rhytisma acerinum*) on Norway maple. This disease is highly visible and may concern the general public, but it does very little damage to the tree.

The City has a fair number of trees (12%) on the street with poor or dead functional health (Figure 6). To improve the level of functional health, dead and over mature trees will need to be removed and future planting efforts should focus on planting a diverse population of urban tolerant trees.

Maintenance

A primary objective of this inventory is to determine the maintenance needs of the City of Flint's street tree population. These maintenance recommendations have been determined from observations of each tree, potential tree site, or stump. The trunk, scaffold branches, and canopy of each tree, as well as the site's location relative to streets, sidewalks, utilities, signs, buildings, and traffic control devices was considered for each maintenance recommendation.

Table 3. Maintenance Recommendations

Maintenance Type	Trees/Sites	Percentage
Train	1,739	5.6%
Thin	383	1.2%
Raise	7,576	24.2%
Clean	13,172	42.1%
Remove	6,134	19.6%
Plant	2,173	7%
Stump	383	1.2%
	31,273	**100%**

The inventory identified four general types of maintenance. Each site was recorded as a tree that requires pruning, a tree that needs removed, a tree site that needs planted, or a stump that should be ground out. Pruning maintenances are further divided into specific pruning types.

The majority (73.1%) of the recorded sites were trees that require some sort of maintenance prune. Unlike woodland or natural environments, all trees in an urban environment require some sort of pruning. This is because of the unnatural urban stresses, a higher likelihood of doing damage to persons or property, and conflicts with buildings, vehicles and people. These trees need pruned to maintain health, improve structure, increase aesthetics, and to reduce risk.

Photo 2 A Training Prune should remove structural flaws like this co-dominant branch that is failing.

Training prunes are recommended for 1,739 (6%) of the inventoried trees. These are all young or newly transplanted trees. Structural flaws such as, multiple stems, co-dominant leaders, and poor branch structure should be removed now. Pruning young trees may be the most cost effective way to increase the value of the street tree population. This is because the work can be done from the ground with hand tools at a relatively low cost. Structural improvements made now will reduce the need for large pruning cuts or branch failures that cause more stress to the tree. Most of the trees in this category are less than 6 inches DBH.

A tree that has no obvious structural defects or dead wood in the crown will need a routine **thinning prune**. This type of pruning is recommended for 383 (1%) of the trees and should be performed on around a seven year cycle. The trees in the other pruning categories should be scheduled for a thinning prune after they receive the pruning currently recommended in the inventory. A thinning prune will remove life branches in order to reduce crown density and improve crown balance.

The **raising prune** category includes 7,576 (24%) trees. This is not surprising due to the fact that most of the inventoried trees were on tree lawns and the City's top five species includes Norway maples and Littleleaf lindens. The low rounded crown of these trees will need to be pruned up to provide adequate clearance for vehicles and pedestrians.

When trees show a high likelihood of branch failure, a **cleaning prune** was assigned. About 42% (13,172 trees) of the inventoried trees need to have a crown cleaning. This is not surprising due to the fact that most of the large diameter trees in Flint have not been on a cyclical maintenance program for several years. A routine pruning program will reduce the number of cleaning prunes required and reduce the amount of risk of harming persons or property in the City.

The number of **removals** in the City of Flint is currently very high (20%). The majority (75%) of these removals are over mature Norway, Silver, and Sugar maples. This is not surprising as these species make up nearly half of the entire street tree population. The removals also include 365 ash trees. Some of these ash trees are healthy now but will need to be removed due to emerald ash borer infestation. A prioritized list of removals can be found in Appendix J.

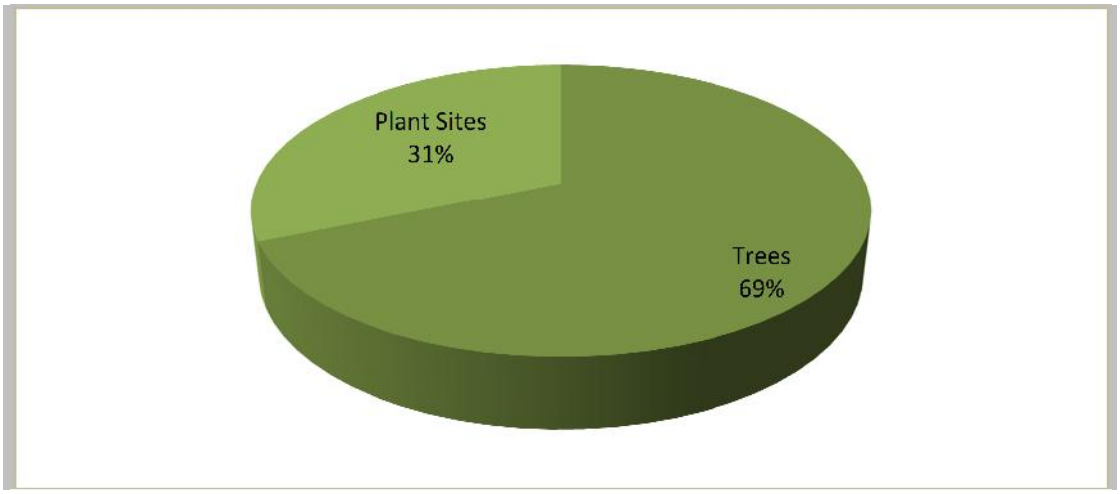
The reduction of tree failures is a primary goal of City tree management. Trees fail from natural causes such as disease, insects, and weather conditions and from physical injury due to vehicles, vandalism, poisoning, and root disturbances, among others. There are three main reasons why trees with an elevated risk of failure should be removed: (1) to reduce potential harm to persons and property; (2) to reduce breeding sites for insects and diseases; and (3) for aesthetics.

Table 4. Sites by Area

Area	Trees	Plant Sites	Stumps
NW	4,742	2,173	96
NE	1,964	*903**	*39**
CW	8,836	*4,065**	*177**
CE	7,447	*3,426**	*149**
SW	3,564	*1,639**	*71**
SE	2,451	*1,128**	*49**
City Wide	**29,004**	***13,334****	***581****

**Number estimated based on percentages in NW data*

Figure 7. Site Descriptions



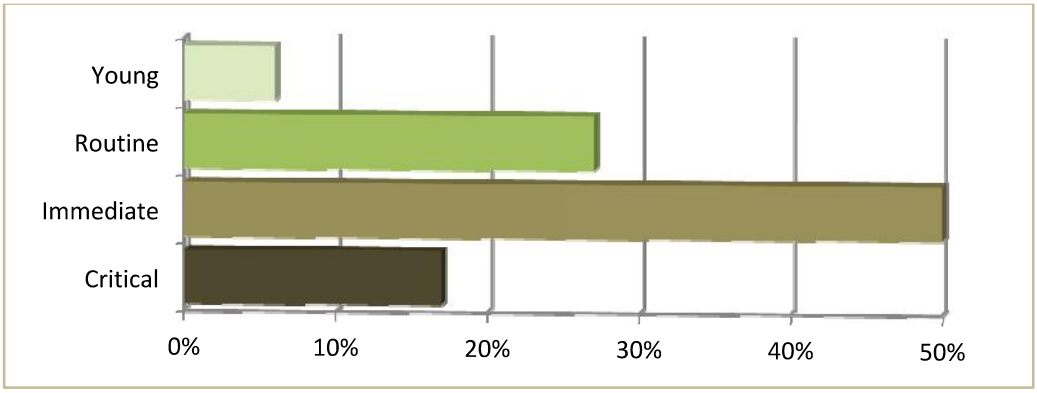
A primary reason this study was commissioned by the City of Flint, was to address the concerns of a diminishing street tree population. Of all the available tree sites in the City, 31% of them are vacant **planting sites**. This leaves the City of Flint with a 69% stocking level. However, this number is more accurately recorded as 47% vacant and 53% stocked when the **stumps** and trees recommended for **removal** are factored in. Increasing the stocking level should be a primary goal for the City in order to maximize the value of the urban forest.

There were only 96 **stumps** on the inventory with an estimated 581 throughout the City. Generally, stumps are removed as part of the tree removal process. Stumps are unsightly and give City streets an unkempt look. They also present a tripping hazard to pedestrians.

Maintenance Priority

Maintenance priority information is collected to provide a basis for determining and prioritizing the primary maintenance recommendations of the inventoried tree population. This information is used in part to determine an appropriate maintenance schedule for the City of Flint. Trees identified with a *critical* priority pose the greatest risk of failure while *young* trees pose very little risk.

Figure 8. Maintenance Priority



Only 33% of the current tree population requires **routine** or **young** tree maintenance. This indicates an excess of high risk trees that are not being managed effectively. Pruning and removal activities prioritized as **critical** or **immediate** make up 67% of the inventoried trees.

The goal of the City's maintenance program should be to quickly eliminate all of the critical concerns, reduce the immediate concerns within the next few years, and eventually maintain the entire street tree population with routine maintenance and training of young trees. Most maintenance prioritized as critical to immediate would be controlled with routine maintenance on a six year cycle.

Failure Size

To further prioritize the level of risk a tree has to damage persons or property, the size of the part most likely to fail was recorded. Failure size may be recorded for the trunk, a branch, or a co-dominant stem. A tree with a large diameter branch that needs to be removed may pose a greater risk than a smaller diameter tree that needs completely removed.

Risk Rating

There is a certain amount of risk involved with every tree. The fact that a tree has suspended mass gives the tree potential energy. A risk rating is an attempt to quantify the amount of potential risk of each tree.

The risk rating is used to help mitigate the amount of risk associated with the street tree population. A risk level is a combination of the health and structural integrity of the tree and the probability of potential targets. The risk rating in this inventory is a sum of the prioritized ranking of *Land Use, Structural Condition, Maintenance Recommendation, Maintenance Priority,* and *Failure Size* data. The total sum of this data gives each record a rating of risk between 1 and 20. The higher the number, the greater the risk associated with that tree. All maintenance activities should start with the trees with the highest risk rating as listed in Appendix J.

A management policy to reduce tree risk can be developed by utilizing this risk rating system. A policy statement should be developed to define the risk reduction goals and possible constraints of attaining these goals. The statement should include the City's understanding of their "duty of care", the person or persons managing the risk reduction, and the budgetary or personnel deficiencies they are working within.

Observations

These are common issues which were documented to help explain specific maintenance requirements for individual trees:

Remove Hardware was recorded for 87 trees. Most of the hardware is staking material used on young trees. All staking should be removed from a tree after one year in order to prevent damage by girdling the stem.

Poor Location is recorded on trees that should not be growing in their current location. These 304 trees are either in a poor location or the wrong species for the location.

Fifty-two trees were *Mulched Improperly*. Most of these trees have had mulch or soil piled too high at the base of the tree.

Photo 3 Linden tree with improper pruning cuts

Trees were recorded as *Pruned Improperly* if improper or excessive pruning cuts were made. In many cases these were the result of residents trying to manage public trees. These 196 improper prunes may or may not be the result of City pruning activities. All pruning on public trees should be conducted by properly trained personnel.

Pest Problem was only collected on 179 trees. Most of these trees showed indications of emerald ash borer infestation.

Photo 4 A silver maple noted with both *Mechanical Damage* and *Root Problem* due to excessive root pruning during sidewalk reconstruction.

Some type of *Mechanical Damage* was identified on 668 trees. This type of damage can be caused by vehicular accidents or careless equipment operation. A fair number of these sites were where sidewalk replacements had taken place.

Cavity/Decay is noted on 2,973 trees. This is primarily noted to inform maintenance crews of the reason for the recommended maintenance where it may not be obvious.

Root Problems are often overlooked when maintenance crews work on or near trees. The 871 trees marked as having poor roots may have girdling roots, fungal infection, damage from construction activity, or just inadequate structure.

Over mature, pest infested, stressed, or damaged trees which are not expected to recover where noted as *Serious Decline*. There are 430 of these trees in the inventory. Almost all trees noted with serious decline are recommended for removal.

Site Characteristics

In addition to the tree data, information about the site was collected. This information will help the City make decisions on what trees are appropriate for which sites and how trees may impact the area they are growing in.

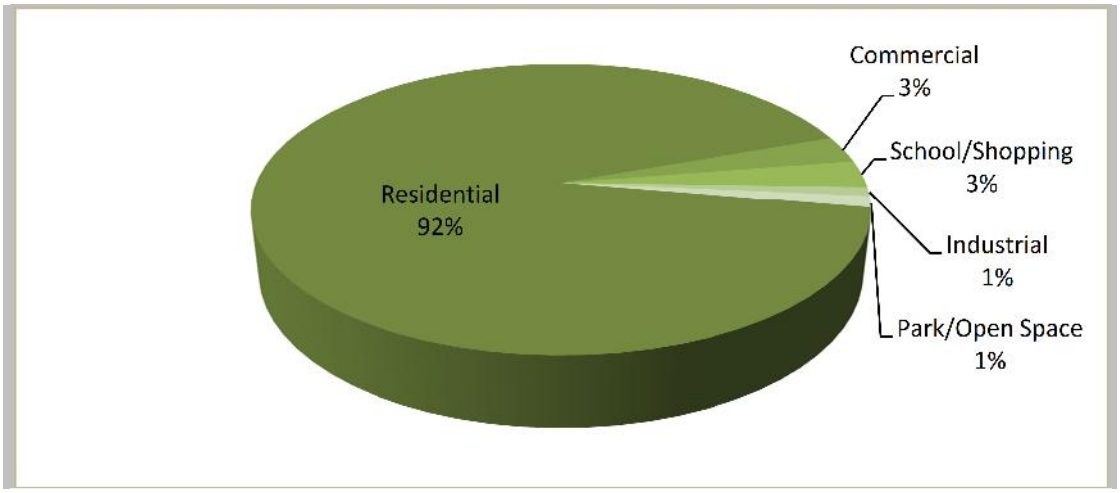
Managed

This field indicates who is responsible for the maintenance of the tree based on its physical location. Because this is an inventory of trees on the public right-of-way, all but two of the inventoried trees are managed by the City of Flint. Two of the trees on the inventory were recorded as managed by *both*. This is because portions of the tree's trunk were growing on the City right-of way and private property. These trees may legally be the responsibility of both property owners.

Land Use

Trees may be affected by or conversely have an effect on the area in which they are growing. This is based in part on the type of land use in that area. The most significant impact of land use in Flint is the frequency of traffic, both pedestrian and vehicular. Since an important factor in calculating risk is the frequency of potential targets, street trees near commercial shopping areas and schools are evaluated with increased risk. Most of the City's street tree sites (28,858) are in **residential** areas. These areas are considered high target areas with a higher risk factor than the commercial, industrial, and park locations, but not as high as school and shopping areas.

Figure 9. Land Use



Location

The type of space available for tree growth was recorded. The location types include: *Yard*, *Tree Lawn*, *Well/Pit*, *Median/Island*, *Other Un-maintained,* and *Other Maintained*. The majority (94%) of the inventoried trees and sites are located in tree lawn areas. This is the lawn area within the right-of-way between a curb and a sidewalk. Yard sites are sites within the right-of-way on privately maintained parcels with no tree lawn and account for only 2% of the inventoried locations. Another 2% are growing in other maintained areas. These are locations that are most likely being maintained by the City in areas bordering wooded natural areas or parks.

Root Space

Root space is the narrowest distance (in feet) that will restrict the natural spread of the root system. This field is used to further define the available space for root growth within each *location*. The amount of root space available is a major determining factor as to the appropriate species selected for a site. Areas with unrestricted root space were recorded as *99*.

Hardscape Damage

Sidewalk or curb damage was recorded when the inventoried tree had a root system that was causing damage. Damage to sidewalks by trees causes tripping hazards for pedestrians and can be the source of many conflicts between the City trees and residents. This type of hazard may be avoided by planting the right tree in the right place. Only sites with an significant amount of damage on an otherwise undamaged tract of sidewalk were recorded. 3,803 of the tree sites in Flint had a notable degree of hardscape damage.

Photo 5 Significant hardscape damage caused by tree roots.

Wires

Of the 29,004 trees that were collected in the inventory, 7,942 (27%) are identified as having utilities above or immediately adjacent to them. Noting the presence of utility lines is necessary when planning pruning activities and can be used to identify which sites are more suitable for small growth habit tree species that will not interfere with utility lines when they mature.

Conflicts between trees and power lines are one of the challenges the City must address. Almost fifteen percent of the entire street tree population has been negatively impacted by utility line clearance. Most trees that have been topped or otherwise pruned excessively due to utility line clearance were recorded with poor *structural conditions*. In order to avoid these conflicts in the future, more appropriate species must be selected when planting under wires.

Figure 10. Condition <u>without</u> Wires

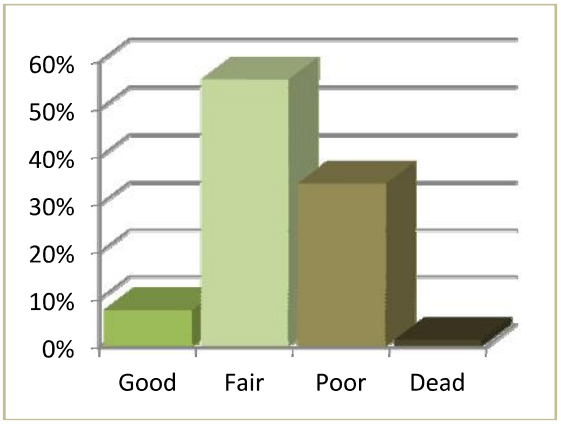
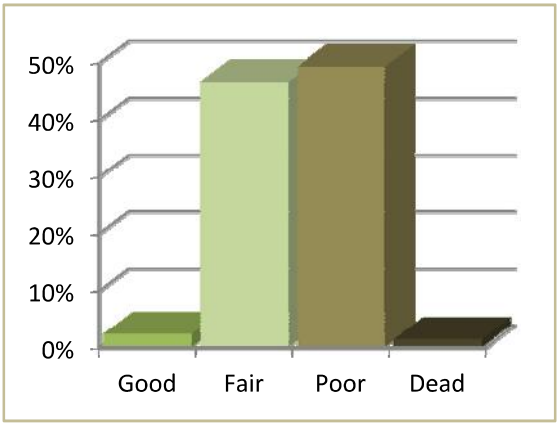


Figure 11. Condition <u>with</u> Wires



Emerald Ash Borer Management

The emerald ash borer (EAB) (*Agrilus planipennis)* is an invasive pest that is threatening the existence of all ash (*Fraxinus*) trees in North America. In an effort to control the artificial spread of EAB, the entire State of Michigan has been included in a Federal quarantine to prohibit the movement of regulated materials. It is illegal to move ash trees, ash logs, ash branches, ash wood chips, ash bark, and all hardwood firewood out of the quarantine area. (Appendix G)

By implementing the provisions in this management plan, The City of Flint is attempting to mitigate the disruption to its urban forest caused by the pending infestation of EAB. Taking a proactive approach to this invasion will enable the City to address public needs in an efficient and effective manner.

Monitoring

State trapping and detection programs will no longer be conducted in the 68 contagious counties of the Lower Peninsula. This is due to the fact that the area has already been designated as a Level One quarantine. All monitoring must now be conducted on a local level. All ash trees in the inventory have been listed as removals as some signs of infestation were already present. The removal list can be found in Appendix G.

Treatment

Based on the efficacy and cost of EAB treatments, the City of Flint will not treat ash trees within the public right-of-ways.

Residents or business owners may wish to treat individual trees that they deem worth the long term cost. This may include trees that provide an essential aesthetics, personal memories, or unique appeal. These people should be made aware of a treatment option that is currently being utilized by tree care professionals and showing promise as an effective control. Information on this treatment has been provided in Appendix H. Local tree companies will be able to provide more information on tree preservation services

Public Ash Tree Removal

The City will use this inventory to prioritize and manage the removal of ash trees. Prioritization of the removals will be based on risk abatement, nuisance, and budget. Ash trees will be removed on an ongoing basis. State and/or Federal grant opportunities will be pursued to help cover the cost of ash tree removal and replacement.

Private Ash Tree Removal

Property owners are encouraged to prepare for the loss of all ash trees. Removal cost will be much higher after the death of the trees. Dead trees are hazardous and may require higher rates from tree care companies. Because the local market will be flooded with removal work, many tree care companies may pass on difficult removals in order to perform the more convenient, more profitable removals. There may also be an increase in unqualified tree workers. Property owners should only hire tree care professionals who are insured and ISA Certified.

The City, now faced with the potential for a large quantity of hazardous private property trees that may affect adjacent private and public properties, should review all existing tree ordinances. The City will need some authority in the removal of all dead, dying, or diseased trees on private property.

Examples include:

Example 1

111.11 Public Nuisance

The superintendent shall have the right to declare any tree or shrub growing upon private property that is:

(a) Interfering with the use of any public area,

(b) Infected with an infectious plant pest, or

(c) Endangering the life, health, or safety of persons or property, as a public nuisance.

111.12 Abatement of Nuisance

If the Superintendent determines, with a reasonable certainty upon inspection or examination, that any nuisance tree or shrub, as herein defined, exists in or upon any private premises, he shall notify, in writing, the owner or tenant having charge of such premises. Within 30 days after the issuance of such a notice, the person shall cause treatment, trimming, or removal and destruction of the nuisance as directed in the written notice. No damages shall be awarded the tenant. Should the owner or tenant neglect to comply with the terms of the written notice within 30 days after receiving it, the Superintendent shall cause the removal, treatment, or trimming of the nuisance. The expense thereof shall be assessed as a lien against the property for collection as other taxes.

Example 2

111.11 Dead or Diseased Tree Removal on Private Property

The City shall have the right to cause the removal of any trees on private property within the City, when such trees constitute a hazard to life and property.

(a) Notice to Remove. Should any person or persons fail to remove trees as herein provided, the City Forester shall order such person or persons, within 30 days after receipt of written notice to remove such trees.

(b) Order Required. The order herein shall be served by certified mail to the last known address of the property owner.

(c) Failure to Comply. When a person to whom an order is directed shall fail to comply within the specified time, it shall be lawful for the City to remove such trees and assess the property owner for the cost of services rendered.

Both of these ordinances would give the City the ability to cause the removal of a privately owned hazardous tree. They also define the City's ability to be reimbursed for 100% of the cost of such a removal. The City may want to consider a reimbursement of 125%-150% of the cost in order to deter property owners from using this ordinance as a suitable way to remove their trees.

Communication and Education

This management plan will be made available to the Mayor, City council, and department heads. All parties will also receive updates through normal channels.

The public will be made aware of the threat of EAB and the consequential cost involved with its invasion through:

- City Web Page: https://www.cityofflint.com
- Informative posters posted in local recreation areas
- Local Newsletters
- Public Meetings

Street Tree Maintenance Budget

This section consists of program projections for all tree maintenance activities and is intended to provide an example of the relative costs that could be incurred by the recommended activities. However, Flint must understand that the budgeting recommendations below are only estimates and are based on the application of sound urban forestry management principles to municipal forestry operations.

This program budget is designed to address the highest priority removal and maintenance recommendations first. Maintenance activities have been prioritized by site in Appendix J. This is intended to reduce potential high risk situations for the public and all associated liabilities. By doing so, the City will greatly lessen the potential of injury to citizens, damage to property, and possible liability litigation.

Tree maintenance costs in Table 5 are based on quotes from reputable tree care companies and are averages extracted from bids received by communities in similar economic regions during the past few years. These costs are an average and are used to estimate the budget projections in this plan.

Table 5. Estimated Maintenance Budget

	Tree Removal			Tree Pruning						Tree Planting		
DBH	Remove	Cost/ Tree	Total Cost	Clean	Raise	Thin	Train	Cost/ Tree	Total Cost	Plant	Cost/ Tree	Total Cost
1-3"	51	$25	$1,275	5	25	0	1111	$20	$22,820	13334	$320	$4,266,880
4-6"	98	$120	$11,760	28	140	24	563	$30	$22,650			
7-12"	513	$120	$61,560	701	1742	96	65	$75	$195,300			
13-18"	1605	$200	$321,000	3513	3046	159	0	$120	$806,160			
19-24"	1884	$325	$612,300	4832	1808	75	0	$170	$1,141,550			
25-30"	1171	$500	$585,500	2402	622	22	0	$225	$685,350			
31-36"	515	$900	$463,500	1020	151	4	0	$305	$358,375			
37-42"	196	$900	$176,400	458	28	1	0	$380	$185,060			
43"+	101	$1,500	$151,500	213	14	2	0	$590	$135,110			
Activity Total	**6134**		**$2,384,795**	**13172**	**7576**	**383**	**1739**		**$3,552,375**	**13334**		**$4,266,880**

			Maintenance	Planting	Total
Total Cost:			**$5,937,170**	**$4,266,880**	**$10,204,050**
Annual Street Tree Budget Over	3	Years :	$1,979,057	$1,422,293	$3,401,350
Annual Street Tree Budget Over	6	Years*:	$989,528	$711,147	$1,700,675
Annual Street Tree Budget Over	12	Years :	$494,764	$355,573	$850,338

*Recommended Maintenance Cycle

The main objective of this budget is to provide reasonable maintenance goals for the City of Flint. Based on the current inventory data and cost estimates, the City could maximize the safety and benefits of the street tree population for $10,204,050.00. While it may not be financially feasible to meet this need immediately, to budget these costs over the course of six to twelve years should be.

A little over forty percent of this budget is to restock the street tree population. The remainder of the budget is to maintain what already exists. While reducing risk and maintaining the current tree population should be the first priority, it is important to understand that without a planting program, the street tree resource is not sustainable. Even if the full recommended planting budget is not available, some sort of planting program must be established to improve the stocking level. The following chapter explains the increased benefits attained by improving the stocking level.

Benefit Cost Analysis

Most communities appreciate trees and believe that they are important. They may however, not understand the full spectrum of benefits provided by trees. This often leads to inadequate funding for street tree programs. In order to justify the cost of management, this report uses the City of Flint's inventory data and i-Tree's Streets model to quantify the benefits provided by this resource. I-Tree Streets output reports are provided in Appendix B.

Replacement Value

The legal value of the City's inventoried street tree population is **$34,124,559.06**. This value assumes the cost to replace every tree with a tree of similar size, species, condition, and location as defined by the CTLA. With this number, it is easy to see what a value trees are to the City's infrastructure. With proper maintenance, the value of the street tree population will actually increase with age. This is unlike other components of the infrastructure like street, sidewalks, sewers, and streetlights.

Benefit Value

An often overlooked value of street trees is what they give back to the community in environmental benefits. Trees reduce energy use, carbon dioxide levels, air pollution, and stormwater runoff. Trees also provide an environment that benefits a community socially, psychologically, and economically. These benefits have value and should be considered when making budget decisions on a street tree management program.

Table 6. Annual Environmental Benefits

Benefits	Total	Per Tree	Per Capita*
Energy	$1,535,452	$52.94	$15.39
CO_2	$206,121	$7.11	$2.07
Air Quality	$266,678	$9.19	$2.67
Stormwater	$1,973,737	$68.05	$19.78
Aesthetic/Other	$1,810,298	$32.42	$18.15
Total Benefits	**$5,792,286**	**$199.71**	**$58.06**

*Based on a population of 99,763

Trees reduce energy costs by modifying climatic conditions. In the summer trees cool the urban landscape with shade and transpiration. In the winter trees block wind and reduce the infiltration of cold air into buildings. These **energy savings** are quantified by an annual reduction of electricity and natural gas use.

A community's carbon footprint is becoming more of a concern as environmental awareness continues to rise. Carbon taxes and carbon credits are now accepted as financial commodities. Flint's street trees can **reduce atmospheric carbon dioxide (CO_2)** by sequestering carbon in plant tissues and by reducing energy use. Conversely, tree maintenance activities release CO2 into the atmosphere by running chainsaws, chippers, and trucks. Dead trees also release the carbon they were holding as they decompose. These factors are evaluated to estimate the value of sequestered and avoided pounds of carbon dioxide.

Trees improve **air quality** by intercepting pollutants such as dust, pollen and smoke. Air is also improved by the absorption of ozone and nitrogen dioxide while at the same time releasing oxygen. The benefits that cause reduced energy use also improve air quality by reducing pollutants associated with energy production.

Stormwater runoff reduction is also a quantifiable benefit of the street tree population. Tree canopies intercept rainfall to reduce the volume of runoff and protect against soil erosion. Root systems absorb water and increase soil infiltration. This benefit should be of interest to the City of Flint as stormwater overflow has been a problem in the past.

The **aesthetic, social, and economic benefit** of trees is obvious but difficult to quantify. The value of some of these benefits is recorded by property values. People are willing to pay more for homes in neighborhood with large canopied trees. People also tend to shop longer and more often in areas that are well landscaped with trees. These benefits are estimated by using real-estate value as they relate to tree canopy.

Benefit-Cost Ratio

In order to justify the cost of maintaining Flint's street trees, the annual benefits need to be compared to the annual costs. By using the budget recommendations in Table 5 of this report and assuming a six year cycle, the annual maintenance costs are estimated to be $1,700,675. The annual benefits that the inventoried public street trees provide as determined by i-Tree Streets analysis is $5,792,286. **This means that the City of Flint will receive $3.41 in benefits for every $1.00 spent on the street tree program.**